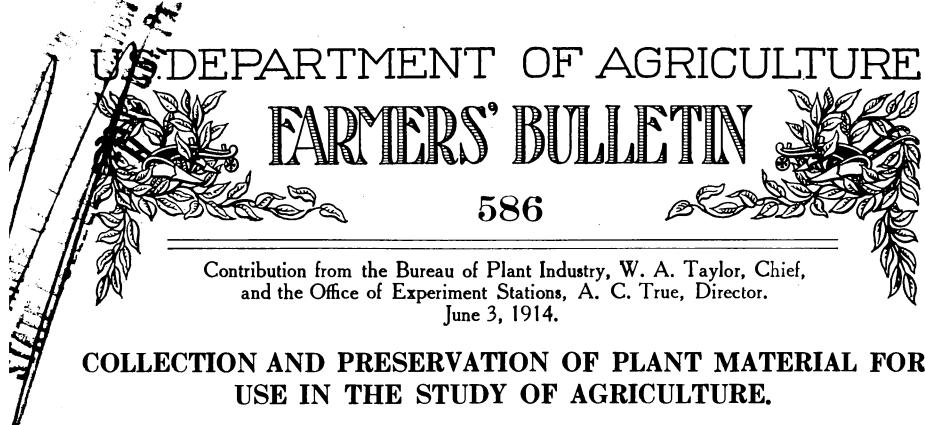


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COLLECTION AND PRESERVATION OF PLANT MATERIAL FOR USE IN THE STUDY OF AGRICULTURE.

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INTRODUCTION.

The purpose of this bulletin is to suggest methods of collecting, preparing, mounting, and preserving plant specimens of various sorts which can be used by teachers of agriculture. To instructors in agriculture who have had special training along these lines, doubtless many of the suggestions here given will seem superfluous; but there are many teachers who are called upon to teach agriculture who have not had such training, and who will doubtless welcome specific information as to how to prepare the materials needed for illustration and demonstration purposes in the classroom.

WHAT MATERIALS SHOULD BE COLLECTED.

The nature of the materials which the teacher should collect will depend, of course, upon the character of the school and the class of work which is taken up by the pupils, as well as upon the locality, the funds available, and the time which the pupils and teacher can devote to the work.

In general, the illustrative materials with which every school should be provided may be grouped into two classes, according to the uses to which they are to be put: (1) Museum specimens and samples, which are to be kept permanently for reference, display, and strictly illustrative purposes only; and (2) working collections, which may be used for display and illustration but the chief purpose of which is to supply the pupils with materials for class study and experimental use. For instructional purposes, the latter group is by far the more valuable, but a permanent collection of specimens and samples of various seeds, plants, and other materials may be very useful to any school, provided, of course, the specimens are accurately labeled and so preserved and mounted that they are readily available for examination.

NOTE.—This bulletin is designed for the use of rural teachers in all parts of the United States.

Materials for class use should, as far as possible, be fresh and in the natural state, rather than dried or preserved, and should, therefore, generally be collected just prior to the time they are wanted and put away only temporarily. No great degree of care or skill will, in general, be necessary to do this. But for a permanent collection in a school museum considerable technical knowledge and ingenuity are often required in preparing and preserving the specimens and preparing convenient receptacles in which to keep them. This is particularly true where the means at hand are limited and the resourcefulness of the teacher must be relied upon to produce inexpensive methods and devices of home manufacture.

No directions are included in this bulletin for the collection of birds' eggs or bird specimens, since it is believed not to be wise to do this in the ordinary school because of the destruction of bird life which would be likely to result and the wrong impressions the pupils might gain.

SOURCES OF MATERIALS.

In recent years, many commercial houses, educational institutions, and Government bureaus have made a practice of distributing collections of specimens and samples of various sorts to schools. Such collections are of great value, undoubtedly, and there is no objection whatsoever to schools securing materials from such sources whenever possible, so long as they do not rely upon these sources for all their illustrative material. But it is a much better practice to have the pupils collect and prepare their own materials as far as possible from original local sources, because of the educational possibilities involved in the process of gathering the various specimens.

Almost any locality affords supplies of seed, plant, and wood specimens, and other materials of vital importance in the study of agriculture; and the work of gathering these specimens will afford definite tasks upon which to center the interest of numerous field trips, so that the danger of aimless wandering which so frequently makes this method of instruction devoid of practical results may be minimized. The instructor who takes his class out into the field with the definite purpose of collecting specimens of weed seeds, for example, has the very best possible opportunity at the same time to teach not only identification of the local weed species but also useful facts as to their relations to soil and climate.

GENERAL SUGGESTIONS FOR FIELD WORK.

It is important that complete and accurate records should be kept for each specimen collected in order to supply the data necessary for the proper labeling of the mounted specimen. Sometimes, as in the case of wood specimens, it will be necessary to mark each sample in

the field, as soon as it is obtained, with the name of the tree from which it is taken, in order to prevent mistakes in naming the mounted specimens. It should be the aim of the instructor to make the fieldwork teach something besides mere methods of collecting, and, with this in view, the pupils should also be provided with notebooks and pencils for making memoranda of things learned on the trip.

All work of this sort should be constructive and never destructive. Indiscriminate picking or digging of wild flowers or unnecessary cutting of branches of trees should not be permitted. Whenever it is necessary to obtain a specimen of a desirable plant or wood, that plant should be taken which can be best spared, if there is any choice. If a branch must be cut from a tree, see that when it is done the tree will be the better off for the pruning.

SUGGESTIONS CONCERNING THE ARRANGEMENT OF MATERIALS.

When plants or other materials are collected for ordinary purposes of study and reference, it will generally suffice to arrange the specimens in their logical order, according to their scientific classifications. When, however, it is intended to prepare a set of specimens for an educational display, very interesting and attractive groups can be arranged to show strikingly the agricultural relationships of the particular plants in question. For example, a display centered about some particular agricultural crop plant might show the different types or varieties of the plant itself; the commercial products manufactured from it; the enemies, such as insects and plant diseases, from whose attacks it needs protection; and pictures showing methods of cultivating and harvesting the crop. A display might be centered about some farm insect pest so as to show the insect in the various stages of its development; specimens of the plant upon which it feeds, showing the injury it does to these plants; specimens of other insects which are hostile to it; and pictures of birds which prey upon it. Exhibits such as these take time to prepare, but they will prove enough more attractive than an ordinary collection to warrant the extra labor and thought involved in their preparation.

COLLECTION OF PLANT SPECIMENS.

WHAT PLANTS TO COLLECT.

In the collection of plant specimens for use in the agriculture class it will be obvious that plants of purely botanical interest need not be included. In general, the plants which should be collected may be divided into two groups: (1) Plants of value to the farmer, both cultivated and wild; and (2) noxious plants or weeds. As a subclass of the noxious plants, special attention should be given to poisonous plants, with a view to making the pupils familiar with them so as to

prevent personal injury from poisoning as well as to enable them to take proper steps for the eradication of these particularly undesirable members of the weed class.

HOW TO COLLECT.

When starting out to collect specimens it will be necessary for the pupil to be provided with some sort of receptacle in which to carry the specimens. The best thing for this purpose is undoubtedly a tin botanical specimen case, such as may be purchased from any school-supply house. But where such a case is not available almost any sort of covered box, such as a pasteboard shoe box, for example, may be used as a substitute, provided it is large enough to allow the plants to be placed in it without crushing. A cover to the box is essential, for the specimens must be kept moist until they can be carried home and prepared for pressing.

In collecting specimens of the smaller plants it will generally be desirable to secure them roots and all, since many of the grasses and sedges can be best identified when the root systems are available for examination. With many of the flowering plants, however, it will be neither necessary nor desirable that the roots be taken up, since to do so would increase the possibility of exterminating desirable species, and the roots, in many cases, will not be essential to the study of the plant.

Unlike the collection of specimens for botanical use, the collection of plants for study in connection with agricultural work generally necessitates the identification of the plant in the field; otherwise the pupils can not know whether or not the species in question is of any importance agriculturally. Assuming, then, that the identity of the plant is known, it will be obvious that later possibility of confusion of identities should be guarded against by properly labeling each specimen as it is collected. For this reason before going into the field it will be well to provide a quantity of labels with strings attached to them, so that one of these may be readily tied to each plant as it is gathered. This label should remain constantly attached to the specimen while it is being pressed and until it is finally mounted in permanent form.

HOW TO PREPARE PLANT SPECIMENS FOR MOUNTING.

Most of the specimens of plants obtained for agricultural study will have to be pressed in order to prepare them for final mounting. Various devices may be adapted for use in pressing plants, some of which will be familiar to all teachers of botany or agriculture. Perhaps the simplest method is to place the plant, carefully arranged so as to avoid folding or crushing, between two layers of blotting paper, and place on these a flat board on which is placed a heavy weight.

It is suggested, however, that instead of blotting paper, driers be used, made of sheets cut from felt paper such as is placed beneath carpets. This paper will readily absorb the moisture from the plant,

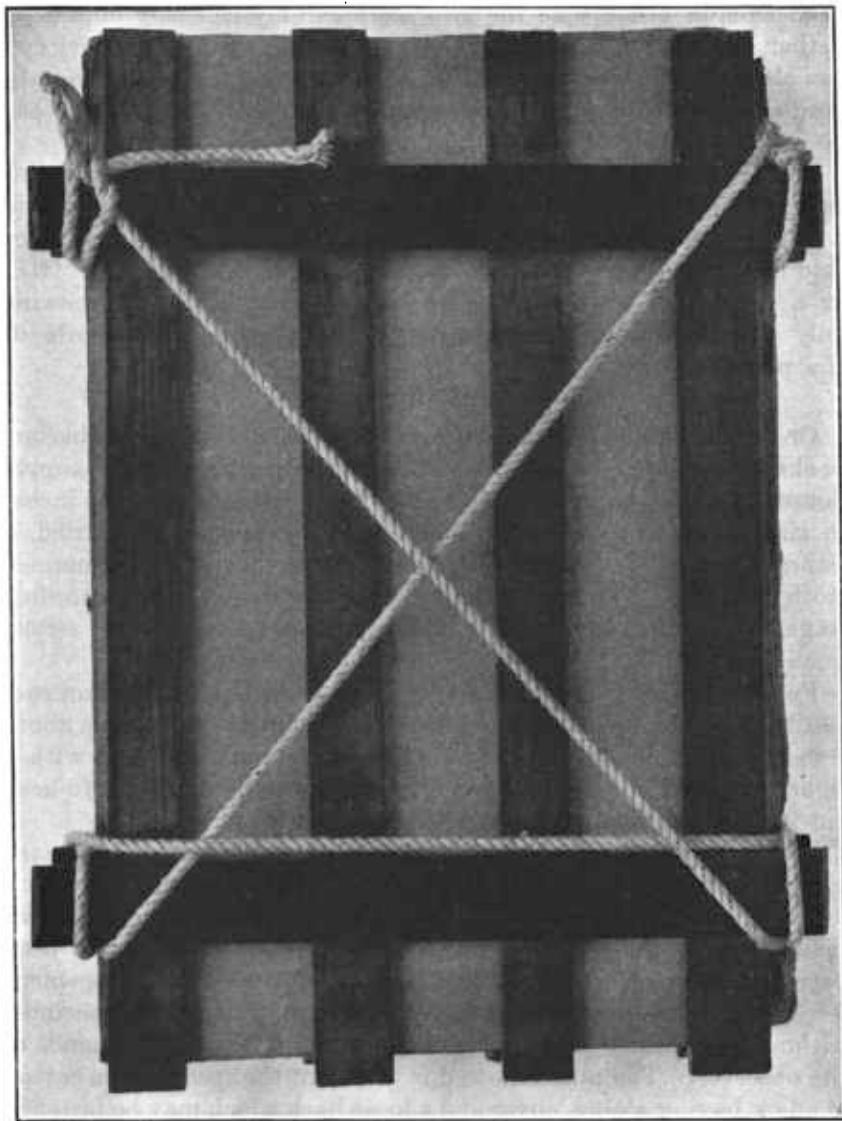


FIG. 1.—Home-made plant press, showing method of arranging rope to get greatest pressure.

but the driers should be changed twice each day for the first two days, and once each day for a week thereafter to give the best results. Instead of the old method of using weights, a very good plan

is to use a set of pressing frames such as those shown in figure 1. These frames may be made of strips $\frac{1}{2}$ inch thick, $1\frac{1}{2}$ inches wide, and 8 inches long. Each frame is 12 inches wide, the crosspieces being 14 inches long, so that they project 1 inch beyond the edge on each side, in order that the two sections may be easily bound together by passing cords about these projecting ends. Ordinary cotton clotheslines may be used for this purpose. By adjusting the cord as shown in the illustration (fig. 1), a considerable pressure can be secured with little effort.

A frame of this size is necessary in order to contain pressing papers of the standard size used by botanists (12 by 17 inches) but a smaller size may be used if desired. If a plant is too long to go into the press, it may be bent in the shape of a "V" or an "N"; or a portion of the stem at the base may be discarded, showing only the roots and basal leaves and the upper two-thirds of the plant.

MOUNTING.

Ordinarily, dried plant specimens are best kept in herbarium books such as may be obtained, in various sizes, from school-supply houses. The herbarium sheet used by botanists is $11\frac{1}{2}$ by $16\frac{1}{2}$ inches in size, and the plant, after being properly pressed and dried, is either glued to the sheet or fastened to it with slips of gummed cloth or paper. The mounted specimens are then grouped according to genera, each genus being inclosed in a separate cover of strong manila paper.

For convenient filing of the specimens a suitable herbarium case can be easily made out of a cracker box by putting partitions about 4 inches apart in it for shelves. The box should be fitted with a tight door and should be lined with heavy building paper to keep out insects and dust.

Where it is desired to arrange the plant specimens so that each specimen may be constantly displayed, or where specimens such as heads of grain, which can not be pressed, are to be mounted, another plan must be followed. For use in such cases a device has been patented which affords the advantage of an attractive arrangement for display purposes and of the ready examination of the specimen without the necessity of its coming into contact with the hands of the observer. The plan followed is to mount the specimen on cotton in a box having a glass cover and a loose back which may be fastened down tightly upon the cotton so as to hold the specimen embedded in the cotton against the glass, through which it may be examined. The object to be mounted is placed in the mount upon the glass face down; upon it are placed layers of cotton batting so as to fill the box completely (fig. 2), the back is then put on and fastened down

tightly upon the cotton, thus holding the object securely in place against the glass front (fig. 3). Glass-covered mounting boxes, like that described, generally made of heavy cardboard, can be purchased in various sizes from supply houses.

A few plant specimens, such as some of the fleshy fruits or roots of leguminous plants showing nodules, can not be satisfactorily preserved by drying. Such specimens may be preserved in glass jars in preservative fluids. A large-mouthed receptacle of some sort is required for this purpose. The best kind is, of course, the square

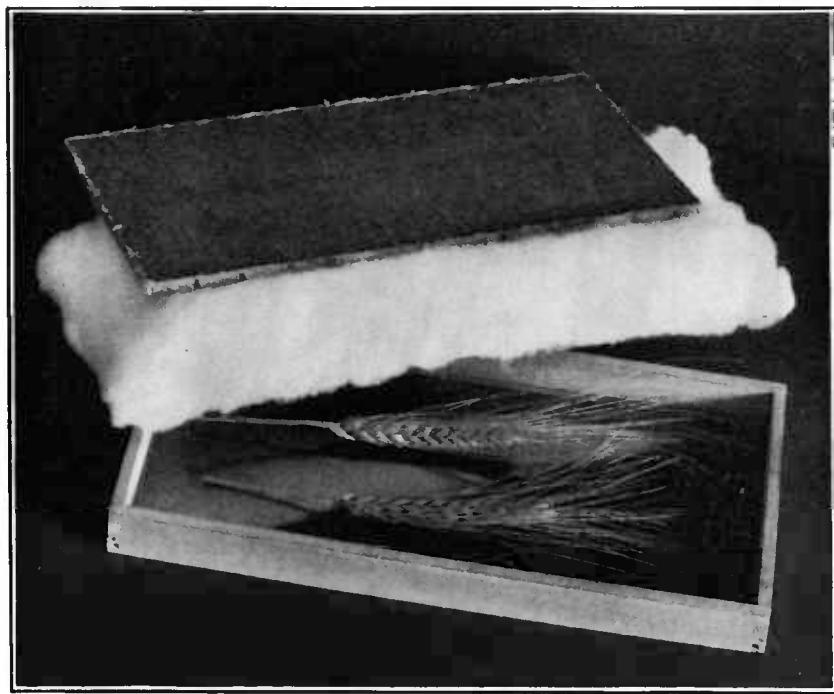


FIG. 2.—Method of mounting heads of grain under glass.

museum jar, but lacking this the next best thing is an ordinary fruit jar. Delicate specimens of this sort must be carefully protected in the field, when being collected, from excessive drying or bruising. This can be done by wrapping each specimen separately in pieces of moist newspaper. Specimens of roots and similar articles should be carefully washed before mounting. An old toothbrush will be found to be an excellent thing for this purpose, since by its use particles of dirt which would otherwise be hard to get at can be easily removed. After being washed the specimen may be placed in a 2 or 3 per cent solution of formalin (using formalin with a strength of 40 per cent



Grano-Ken Durum Wheat.

FIG. 3.—Heads of grain mounted under glass.

formaldehyde) for several days, after which it should be placed in a jar containing a 5 per cent solution of formalin. A simple method of arranging a delicate plant so that it shows well in the jar is to attach a fine thread to the specimen and suspend it thus in the fluid. By holding the end of the thread in the left hand while the cover of the jar is put on, the thread may be fastened so as to hold the specimen in any position desired.

PRESERVING MOUNTED SPECIMENS.

Specimens mounted in fluids, as last described, will, of course, need no protection from insects or mice. But herbarium specimens and those mounted in frames under glass will be subject to such attack and should be protected. A good plan is to place in the herbarium case or mounting frames a few ordinary moth balls or a few naphthalin flakes. These will generally suffice to keep out injurious insects.

COLLECTION OF SEEDS AND GRAINS.

WHAT SEEDS TO COLLECT.

This collection should include seeds of plants similar in character to those suggested for collection as plant specimens. One of the first collections to be made should be samples of the seeds of local weeds, especially those weed seeds likely to be found mixed with farm seeds such as clover or small grains and difficult to distinguish from them. Careful study of such weed seeds will help the pupils to detect adulterations and impurities of commercial seeds. Another collection should be made of the seeds of various crop-producing plants, showing different species and types. Care of course must be taken to see that these samples are pure and true to type if they are to be of any help.

HOW TO COLLECT SEEDS.

A good plan for collecting seeds in the field is to place the seeds, as gathered, in ordinary paper envelopes, writing upon each envelope the name of the plant from which the sample is taken, with such other data as may be desired, such as the date, locality, etc. Small cloth bags, such as those in which salt is sold, may be used instead of envelopes, if desired, and they are less likely to become torn. If the cloth bags are used, a slip of paper on which is written the necessary data concerning each specimen should go into each bag with the seeds. It will also be found convenient to take along a botanical collecting case, hand satchel, or a box of some sort in which to carry the envelopes or bags containing the samples of seed.



FIG. 4.—Permanent collection of farm seeds for school use.

HOW TO PREPARE SEEDS FOR MOUNTING.

All seed specimens should be carefully cleaned of chaff and impurities before they are put into the receptacles in which they are to be finally kept. After being cleaned they should be treated with carbon bisulphid or with formaldehyde, in order to kill any injurious insects or larvæ which may be concealed in or upon them. This can be done by placing the seed in a receptacle and pouring upon a



FIG. 5.—Students' collection of farm seeds.

piece of cotton placed on a saucer in this receptacle enough of the carbon bisulphid or formaldehyde to thoroughly wet the cotton, then closing the cover of the receptacle tightly so as to keep in the fumes. Great care should be taken not to use the carbon bisulphid near a fire, or to strike a match while it is being used, since it is very inflammable and may explode if not properly handled. The fumes of both carbon bisulphid and formaldehyde are very disagreeable and inhaling them should be avoided.

MOUNTING AND STORING SEED SAMPLES.

There are numerous methods by which seeds may be stored for use. The best method will depend upon the purpose for which the samples are to be used and the quantity of seed.

One of the simplest and most convenient methods of mounting samples of small seeds for study and display is to place the samples in small glass vials of 2 or 3 dram size, these vials being then placed in a strong cardboard box arranged with a separate compartment for each vial (fig. 4). Vials with screw tops are better for this purpose than those with ordinary corks, since they protect the seeds

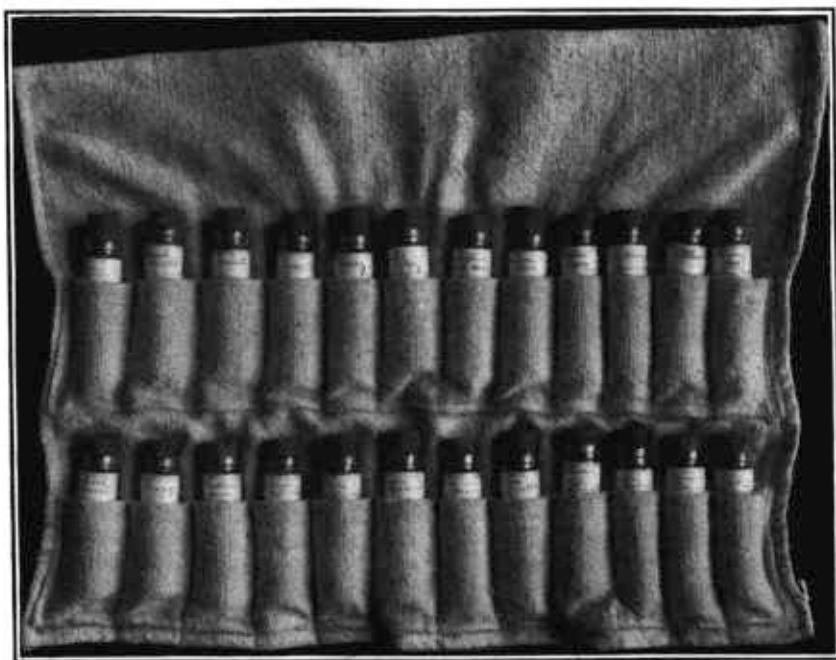


FIG. 6.—Cloth case for carrying samples of farm seeds in vials.

more securely from insects. The vials should be labeled, each with the name of the kind of seed it contains, the place and date of collection, and any other data desired.

If the cardboard box with compartments as suggested can not be obtained, simple holders or cases of various kinds can easily be made which will serve the purpose very well. One such holder is indicated in figure 5. In this the vials are held in place by means of shoe laces passed alternately over, then under, the vials and through the back of the box. Another holder which is especially convenient for use in carrying vials of this sort from place to place, but not so satisfac-

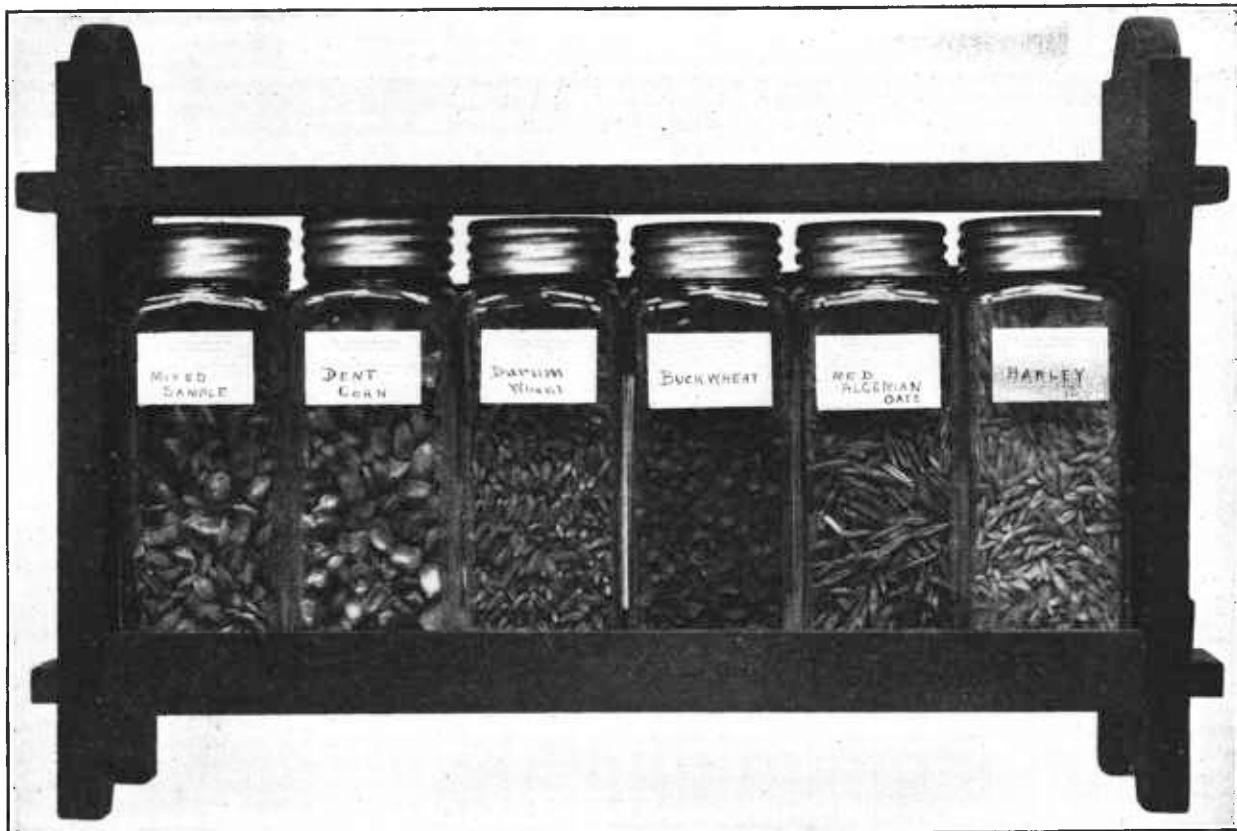


FIG. 7.—Rack for displaying samples of farm seeds.

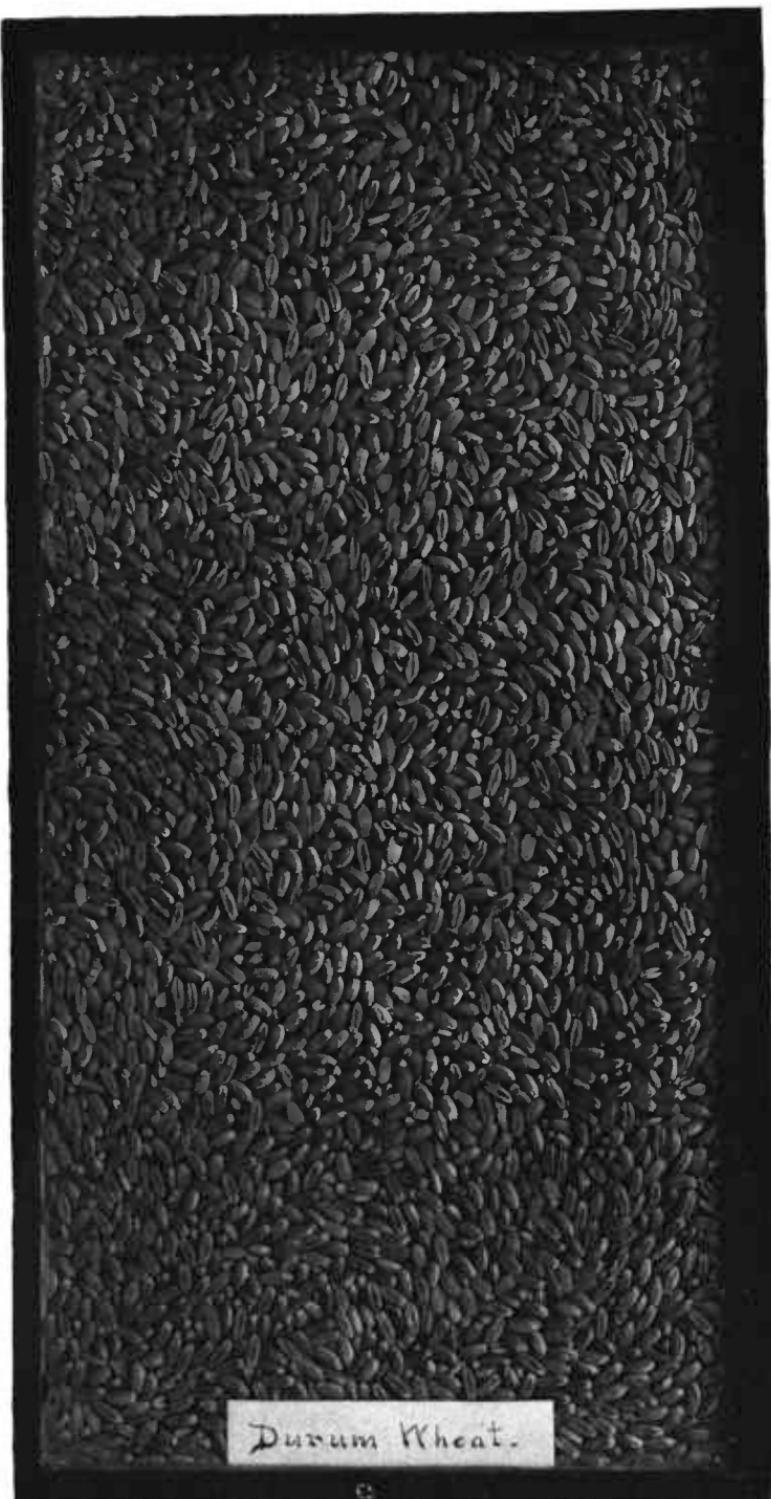


FIG. 8.—Sample of wheat displayed in glass-covered box.

tory for displaying them, can be made of cloth, as shown in figure 6. In this holder strips are sewed upon a rectangular piece of cloth so as to form rows of pockets, each pocket being just large enough to receive one of the vials containing the seed samples.

When it is desired to preserve larger quantities of seeds for future study or grains for experimental planting, larger glass bottles or jars

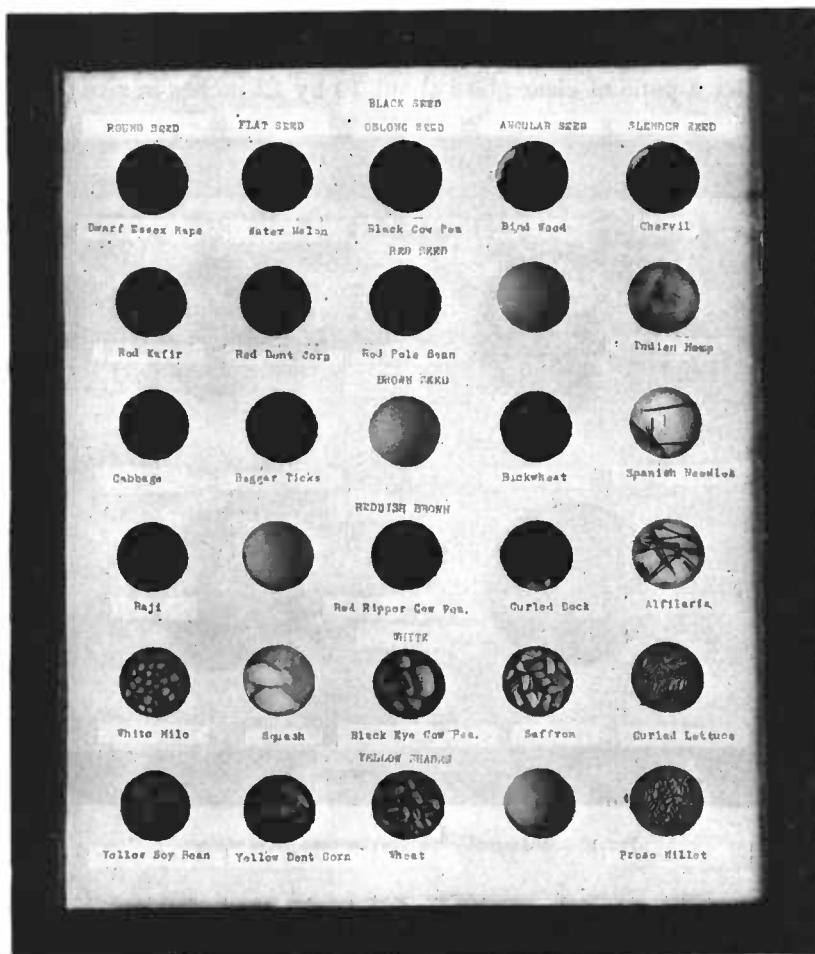


FIG. 9.—Simple method of making a seed-identification chart.

with screw tops or ordinary fruit jars may be used. Of the different kinds of fruit jars those with glass tops which seal with wires will probably be best. But the square glass bottles take up less space (fig. 7). The rack shown in figure 7 is convenient for holding these jars, but they may be placed upon tables or shelves if desired.

Another good scheme for making attractive displays of seeds and grains is to place the samples under glass in boxes like that shown in figure 8. Such a plan has also the advantage of affording good opportunity for the close examination of the sample without the necessity of handling it. The boxes for this purpose may be made in the manner described below.

When only small quantities of seeds are available for mounting, and it is desired to display the samples to better advantage than by the use of vials, a convenient mounting rack is easily made as follows: Get a pane of clear glass about 10 by 12 inches in size (or any

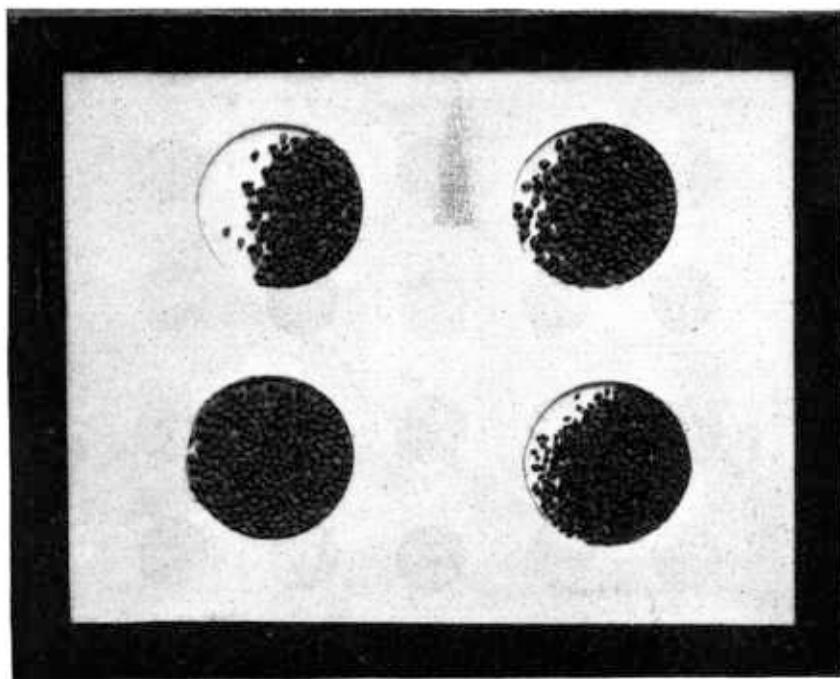


FIG. 10.—Seed samples mounted between panes of glass.

other size that may be desired) and two pieces of $\frac{1}{2}$ -inch board of some soft light wood, such as poplar or basswood, of the same dimensions as the pane of glass or slightly larger. On one of these boards rule lines both ways, spacing them about $1\frac{1}{2}$ inches apart. At each of the intersections of these lines bore 1-inch holes through the board. Now nail or glue this board to the other one. Each of the holes in the upper board will then form a pocket, in which a sample of seed or grain may be placed. A label with the name of the kind of seed and the place and date of collection should be pasted beneath each pocket. By arranging them in a form and color series,

as shown in figure 9, comparison and identification are facilitated. The pane of glass should now be put on to form a cover for all the pockets, thus holding the seeds securely in place. The glass may be held tightly over the pockets by placing the whole mount in an ordinary picture frame and fastening it in with small nails. In the case of small seeds, sheets of heavy cardboard may be substituted for the pieces of board, and the cardboard and glass may be held together by binding the edges with gummed paper, such as the ordinary passe-partout binding, instead of putting the mount into a frame (fig. 10). By using smaller panes of glass, such as discarded photographic

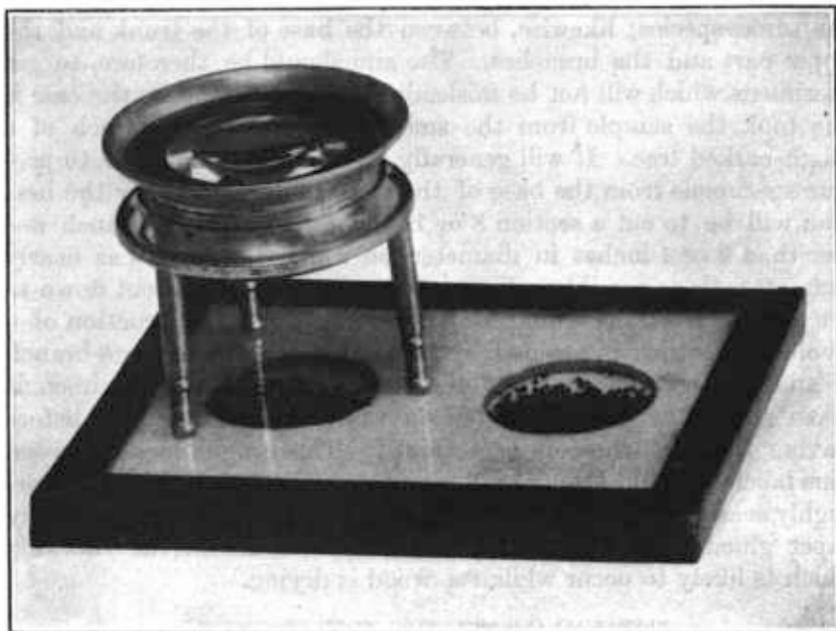


FIG. 11.—Using the microscope to study seed samples.

plates, numerous small mounts may be made which may be easily handed about in the class. This method of mounting has another great advantage in that when mounted in this way the seeds may be easily examined under a microscope (fig. 11).

PRESERVING SEED SPECIMENS.

Seeds treated as previously directed and mounted in tightly closed vials, jars, or in the tight frames described will not be very likely to suffer damage from insects or other sources. As a further precaution, however, in the case of jars that are opened frequently, it may be well to drop into each receptacle a few moth balls. This will prevent insect attack for some time.

COLLECTION OF WOOD SPECIMENS.

HOW TO COLLECT.

The best time to collect wood specimens is in the autumn, when the fruit is more or less mature and the leaves have not yet fallen, for the leaves and fruit are often important aids in determining the identity of the trees, and the wood at this season contains less moisture than earlier in the season.

The specimen should, as far as possible, display features of bark and wood that will be characteristic of the tree from which it is taken. It is important to note that there is much difference in the appearance of the bark between the young tree and the old one of the same species; likewise, between the base of the trunk and the upper part and the branches. The aim should be, therefore, to get specimens which will not be misleading, such as would be the case if one took the sample from the smooth-barked young branch of a rough-barked tree. It will generally be impossible, however, to procure specimens from the base of the tree trunk. Probably the best plan will be to cut a section 8 or 10 inches long from a branch not less than 3 or 4 inches in diameter, on which the bark is as nearly characteristic as possible. Young trees should never be cut down to get sections from the trunk, for to do so entails the destruction of a whole tree, which is avoided by taking a section of a large branch of an old tree. The name of the tree from which the specimen is taken should be plainly written on the wood with a pencil before leaving the spot where it is obtained. The rough blocks of wood thus labeled should then be put away and allowed to become thoroughly seasoned before anything further is done with them. Heavy paper glued over the ends of the block will lessen the checking which is likely to occur while the wood is drying.

PREPARING AND MOUNTING WOOD SPECIMENS.

When the blocks of wood have become thoroughly seasoned they may be finished off in any shape or manner that may be desired. Perhaps the best way is to split off one side of the block to a depth equal to about one-third of its diameter, making a flat surface at right angles to the radius, thus showing the grain of the wood. One end of the block may then be cut squarely across and the other may be sloped at an angle of about 45° from the bark-covered surface out to the flat face (fig. 12). In the square-cut end a small screw eye may be inserted and the block may then be hung, with the others similarly prepared, on nails or hooks in a strip of molding on the wall or in a cabinet. Wood specimens prepared in this way can be taken down for examination, and may be conveniently packed when it is desired to move them from place to place. A label bear-

ing the scientific name and the common name of the species, the date and place of collection, and other data should be attached to each specimen.

Another method of mounting wood specimens is shown in figure 13. In this case, both ends of the blocks are cut squarely across and a piece is split off one side so as to show the grain of the wood. The

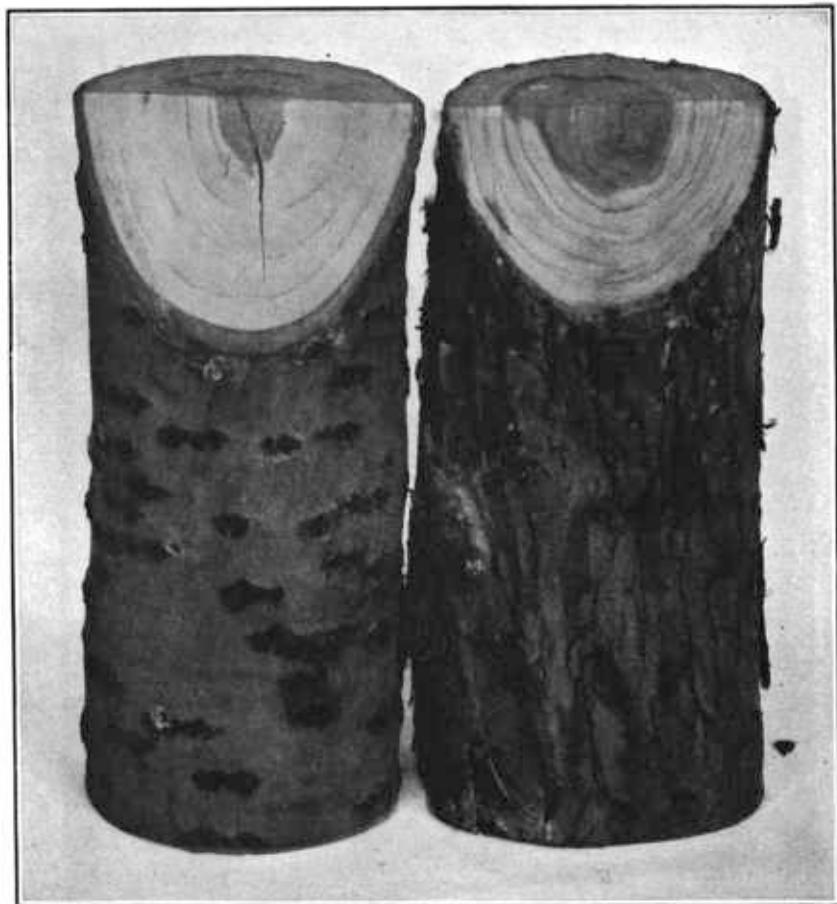


FIG. 12.—Wood specimens prepared for study.

blocks are then placed in racks, as shown in the illustration, and are fastened in place by small nails driven into the tops and bottoms through the boards of the rack.

These mounting racks are made of one-half inch materials, as wide as the specimen blocks are thick. The end uprights are cut so that one rack may be placed upon another, leaving spaces between in

which may be placed specimens of the fruit of each species of tree represented by the wood specimens, if so desired (fig. 13).

In preparing the wood specimens it is a good plan to smooth off the split or sawed surfaces by scraping them with the sharp edge of



FIG. 13.—Method of mounting wood specimens in racks.

a piece of glass, then sandpapering them well. An application of linseed oil will help to prevent possible cracking of the wood, and will also bring out the colors and grain of the wood more clearly. A coat of varnish may be applied if desired to give the specimens a still more "finished" appearance.

COLLECTION OF FUNGI, LICHENS, AND MOSSES.

WHAT FUNGI TO COLLECT.

There are two important groups of fungi of which specimens should be collected for study in connection with the subject of agriculture. The first of these are what are known as *parasites*. These fungi secure their sustenance from a living "host," and are therefore injurious to the plants upon which they draw for a livelihood. Examples of these fungus parasites are the rusts, smuts, and mildews. The second form of fungus growth which should be studied is the *saprophyte*. These fungi live upon dead or decaying organic matter

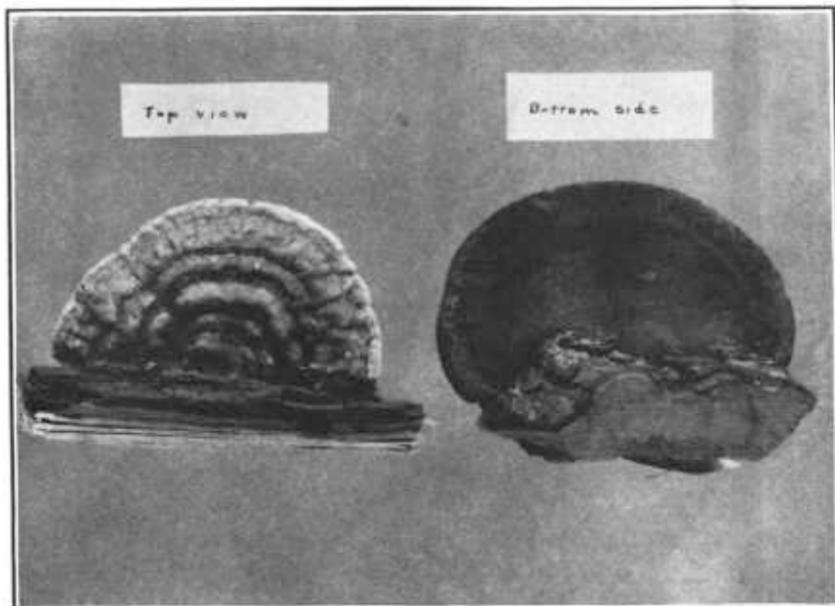
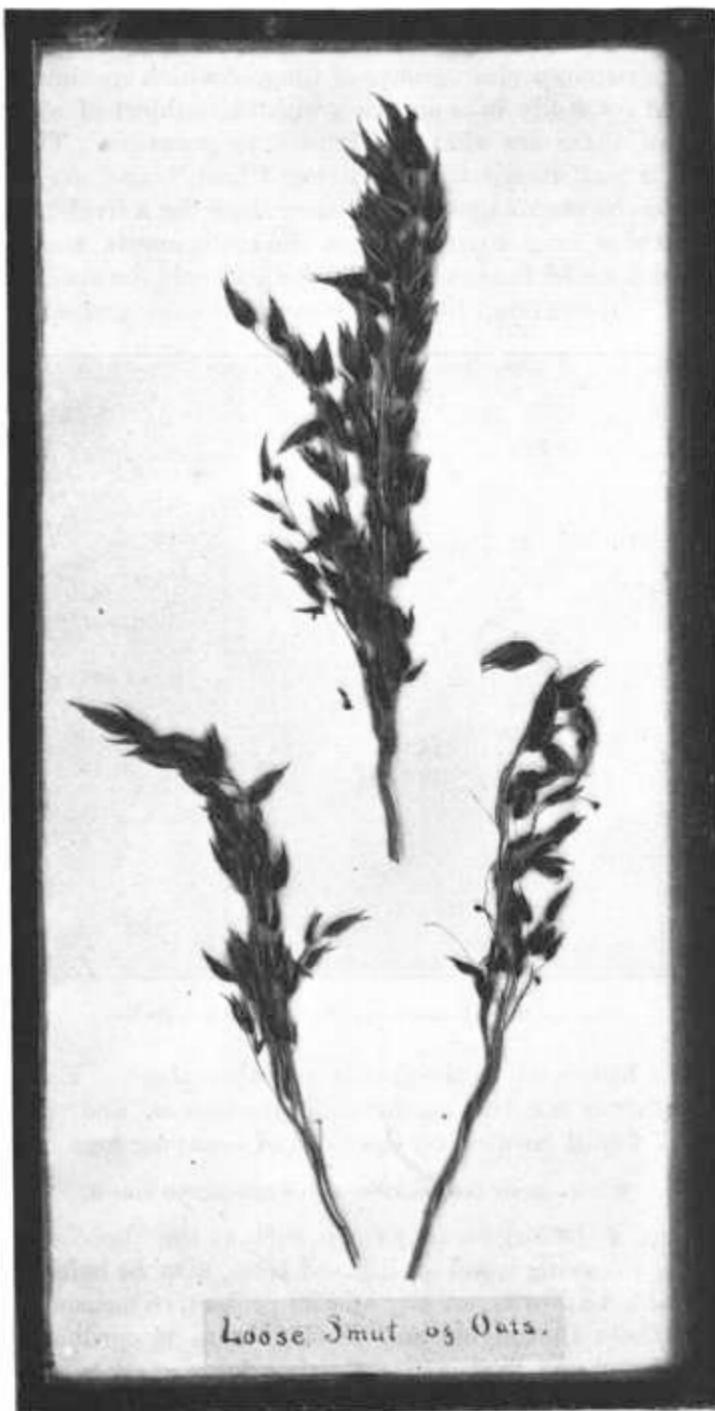


FIG. 14.—How a bracket fungus should be cut from the tree.

and may be beneficial to the growth of other plants. Examples of the *saprophytes* are the mushrooms, toadstools, and the woody "brackets" found growing on the sides of decaying logs.

METHODS OF COLLECTING AND PRESERVING FUNGI.

Specimens of the large woody fungi, such as the "brackets" which grow on the decaying wood of diseased trees, may be safely kept for a considerable time without any special protective measures, simply by drying them thoroughly and placing them in cardboard boxes properly labeled and filed. In collecting fungi such as these, it is best to secure with the specimen a section of the wood or other material to which the fungus is attached, in order to show the relationship which it sustains to the fungus (fig. 14).



Loose Smut of Oats.

FIG. 15.—Diseased heads of oats mounted under glass on cotton.

The difficulties in the way of collecting the moist and fleshy fungi are much greater. Some of these species are gelatinous, while others break down into jelly-like substances in a few hours, and it will be found, in many cases, impossible to preserve good herbarium specimens. A few of the more leathery forms may be preserved in fairly good, though shrunken state, by drying them rapidly, either by exposure to the sun or by artificial heat.

Some of the parasitic fungi, such as those found upon the leaves of plants, may be preserved by pressing and drying the leaves which form the "hosts" in the manner described for the preservation of



FIG. 16.—Method of mounting lichens under glass.

plant specimens. (See p. 4.) The collector should be careful, in such cases, to identify properly not only the parasitic fungus but also the host. If the fungus appears on the twigs as well as the leaves, specimens of both should be obtained. These forms can then be mounted and labeled on ordinary herbarium sheets, just as in the case of flowering plants.

The grain rusts and smuts are among the forms of fungi which it is most important that the student of agriculture should study. A good plan for mounting these specimens is to collect samples of the plant, showing the diseased condition, and mount them in a glass-covered box on cotton in the manner described on page 6 (fig. 15).

All of the soft, fleshy fungi, such as the mushrooms, may be preserved in liquids and kept in closed jars or bottles. A good formula for a preservative solution is as follows: Alcohol, 1 part; formalin, 1 part; distilled water, 15 to 20 parts.

COLLECTING AND PRESERVING LICHENS AND MOSSES.

The mosses and lichens are among the forms of plant life least known to children, as a rule, but some of the more common forms can be easily collected and mounted. The pads of mosses may be taken up with a sharp spade or knife, and should be dried thoroughly before mounting. The lichens, which will be found growing on tree trunks and exposed rocks, generally may be removed readily with a knife, and should also be dried.

A good way to mount specimens of this sort is as follows: Secure two small plates of glass of any size desired, such as discarded photographic plates which have been thoroughly cleaned. Fasten the specimen, face up, to one of these glass plates by means of a little glue. Upon this glass plate, around the edges, run a strip of wood or heavy cardboard, so as to make a sort of box deep enough to hold the specimen, gluing the lower edge of this strip to the glass on which the specimen is fastened. Then cover the upper edge of the strip with glue and lay the other glass upon it, thus forming a closed box or case, its two sides being of glass. Now, bind the edges of this box with passe-partout binding paper (fig. 16). When specimens are mounted in this way it is possible to examine both their upper and lower surfaces, and the mount will last for years if carefully handled.

